Enhanced ADS-B

Adding Additional Surveillance Functionality to the UAT Data Link

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Detect the Difference

NGATS Plan Calls for Enhanced Data Link

"Position and intent information received from individual aircraft ... will support homeland security and national defense needs ..."

"Law enforcement and other agencies ... must have access to a common integrated operating picture via secure data link, air-to-ground communication systems, ..."

"Create global interoperable communications, navigation, and surveillance infrastructure that can function reliably within available spectrum."

"The integration of surveillance and intent information ... will enable rapid response to defense, security, and other threats."

Data Link Choices

ADS-B links:
- 1090 ES
- UAT
- VDL Mode 4

Other Aviation Links:
- VDL Mode 2, 3
- ACARS

Non-Aviation Links:
- Cellular Telephone
- IEEE 802
- Military Links

ES = “Extended Squitter”

UAT = Universal Access Transceiver

VDL = VHF Data Link

Data Link Considerations
(Used in Multiple Studies)

- Suitable for current and future ATM applications
- Global interoperability, standardization
- Technical maturity
- Consistent with aeronautical safety
- Allocated spectrum
- Spectral constraints of aviation platform
- Transition consideration, amount of onboard equipment
- Cost considerations

No Clear Winner

Link Choice	PROS	CONS
1090 ES	Accepted Worldwide	Congested Spectrum
UAT	Accepted in US for GA	Limited Worldwide Acceptance
VDL Mode 4	Partial Acceptance in Europe	Congested Spectrum
Other VDL	Equipment available, some integration	Congested Spectrum
Satellite	Equipment and Services Available	Niche Applications, Costly for Full Deployment
Non Aviation	Equipment and Infrastructure Exists	Requires Development for Aviation Needs

UAT Chosen for Experiments

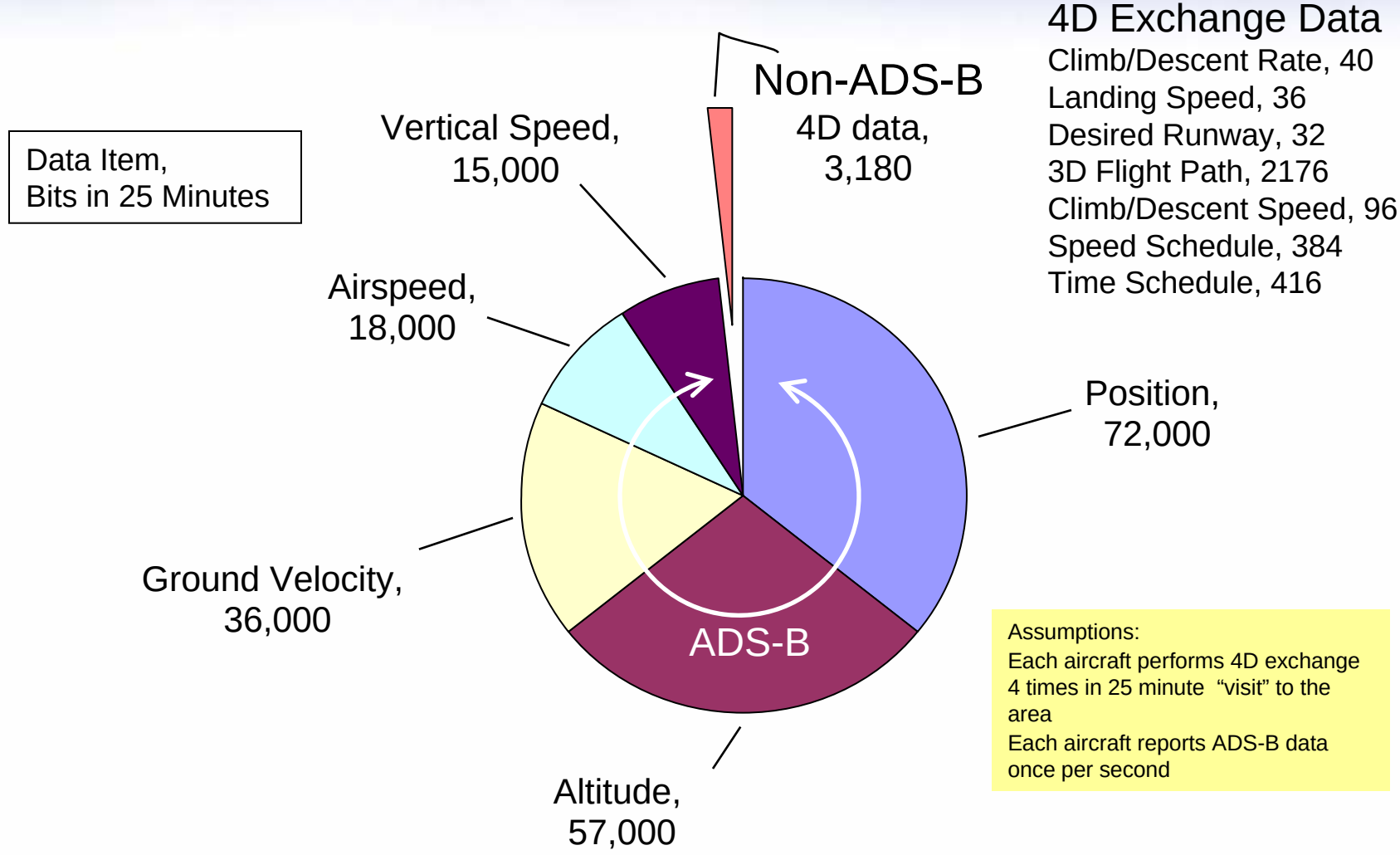
- Developed for aviation, standardized in US, international underway
- Demonstrated for ADS-B surveillance
- Not a congested band, possibility for additional availability in DME band
- Original design for simplicity leaves room for performance improvement if complexity is acceptable

Garmin GDL 90

Sensis GBT

ADS-B Accounts for Most of the Capacity

4D Data Exchange is Small Data Load



4D Exchange Data

Climb/Descent Rate, 40
Landing Speed, 36
Desired Runway, 32
3D Flight Path, 2176
Climb/Descent Speed, 96
Speed Schedule, 384
Time Schedule, 416

Assumptions:
Each aircraft performs 4D exchange 4 times in 25 minute "visit" to the area
Each aircraft reports ADS-B data once per second

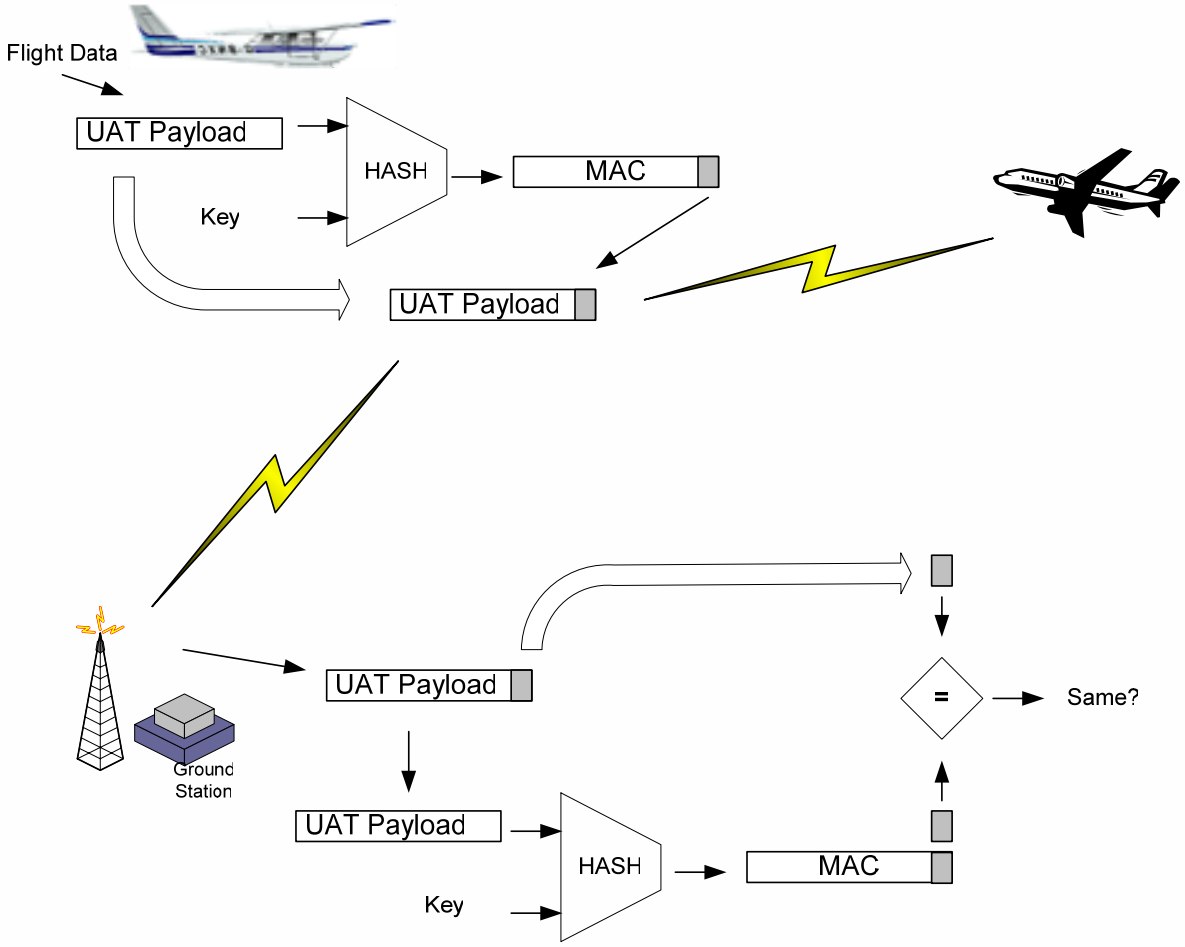
Required Characteristics for Next-Gen Data Link

- Addressable
  - Some messages will be broadcast
  - Some messages addressed, transactional
- Security provisions
  - Ability to authenticate critical messages
  - Ability to encrypt sensitive information
- Expandable message set
  - Not practical to “freeze” applications using the data link
- Flexible media access for variable message rates
- Provisions for message integrity
- Efficiently uses available spectrum

Scope of Current Research

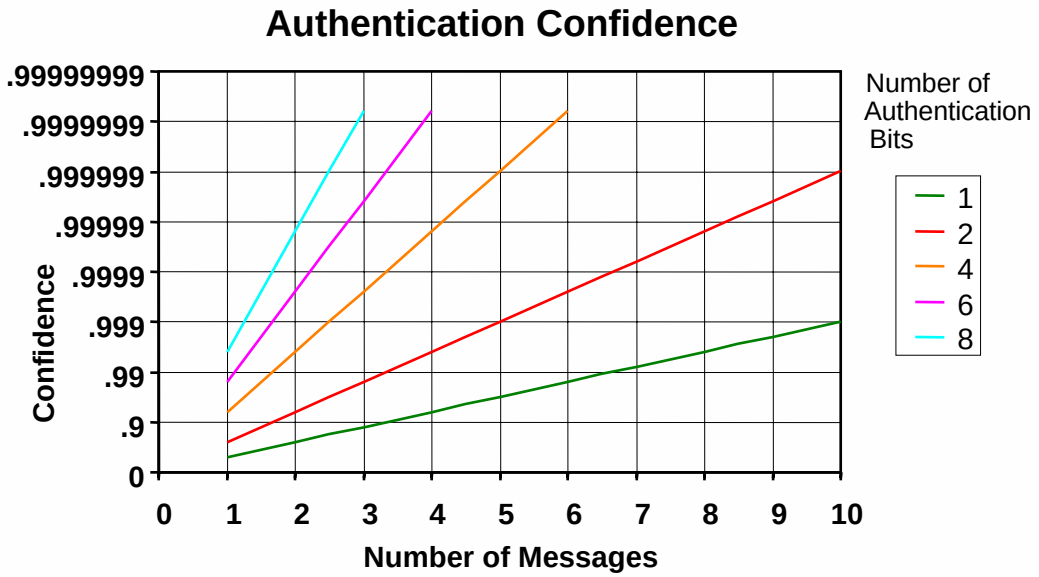
- Demonstrate security enhancements for UAT link
  - Authentication
  - Encryption
  - These two items complete and demonstrated
- Demonstrate methods for increasing spectrum efficiency
  - Media access protocol improvements
  - Alternative modulation
  - Show how the additional capacity can be used
- Develop method for 4D trajectory negotiation
- Consider alternatives for voice channel
  - Compression techniques
  - Conops for voice use

Message Authentication

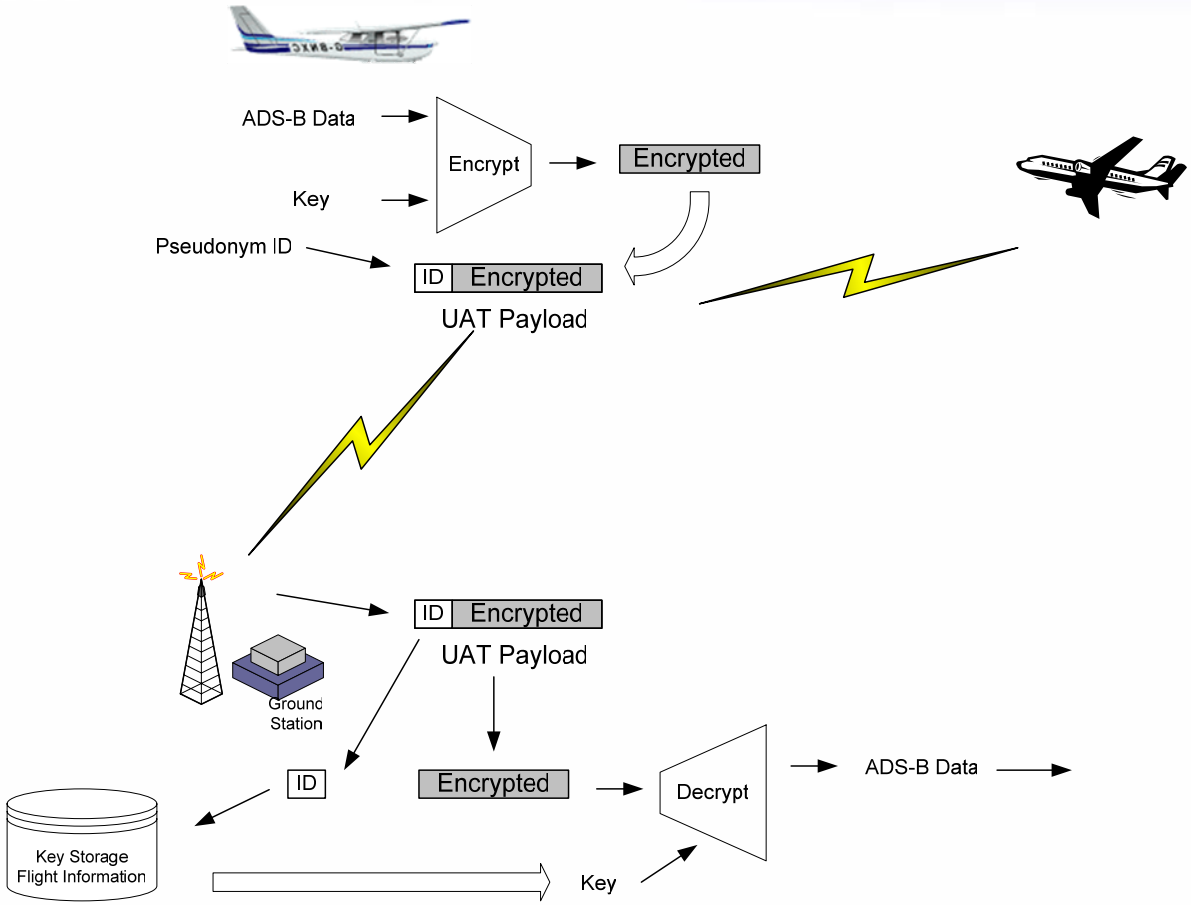


Confidence Grows With Time

- Authenticity of data stream from one aircraft grows quickly with time.
- Missed messages from aircraft slow the confidence growth but do not jeopardize authentication. Messages are independent.
- Unauthentic target is readily identified.

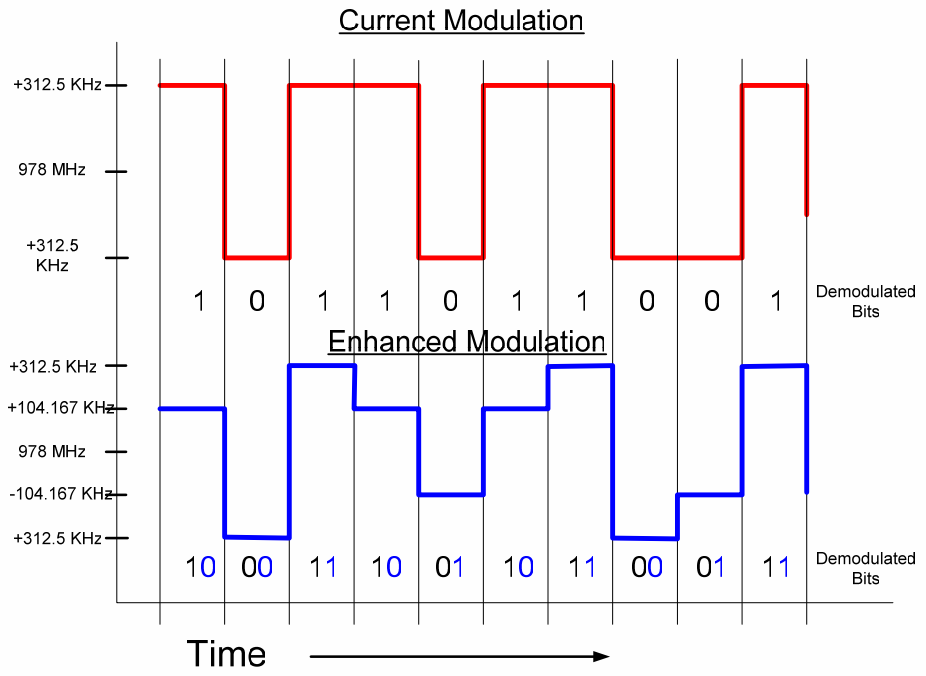


Message Encryption



Modulation Enhancements

- Use 4-state modulation
  - Double the data rate
  - Compatible with existing transceivers
- Not free
  - Range is reduced (1/3 or less)
  - Useful for “close-in” messaging applications
- Not optimal
  - Symbols not nearly orthogonal



Conclusions